

What is claimed is:

1. A liquid filter assembly comprising:
  - (a) a housing defining an interior and having: a liquid flow inlet arrangement; a first circulation loop liquid flow outlet arrangement; and, a tank reservoir liquid flow inlet/outlet; and,
  - (b) a suction filter assembly secured to the liquid filter assembly and positioned in a liquid flow communication with the reservoir liquid flow inlet/outlet; the suction filter assembly including:
    - (i) an extension of suction filter media defining a central volume; and,
    - (ii) a first, non-helical spring, directionally biased valve arrangement comprising a ring shaped valve member having at least one cut valve therein positioned and configured to:
      - (A) readily permit liquid flow from a tank reservoir through the suction filter media and into the housing interior; and,
      - (B) to resist liquid flow from the housing interior, through the suction filter media and then into the tank reservoir.
2. A liquid filter assembly according to claim 1 wherein:
  - (a) the ring-shaped valve member has a plurality of flap valves therein and defines an internal volume.
3. A liquid filter assembly according to claim 2 wherein:
  - (a) each flap valve is a u-shaped flap valve positioned to point around a central axis of the suction filter assembly.
4. A liquid filter assembly according to any one of claims 1-3 including:
  - (a) a flow/pressure regulation valve positioned to regulate flow from within the housing into the tank reservoir.

5. A liquid filter assembly according to claim 4 wherein:
  - (a) the flow/pressure regulation valve comprises: a valve seat having an aperture therein; a valve member; and, a biasing member.

- 5 6. A liquid filter assembly according to claim 5 wherein:
  - (a) the flow/pressure regulation valve comprises a slidable valve member;
    - (i) the slidable valve member of the flow/pressure regulation valve being selectively biased, by the biasing member, into sealing relation with the valve seat;
    - (ii) the valve seat of the flow/pressure regulation valve being positioned between the slidable valve member of the flow/pressure regulation valve and the internal volume defined by the ring-shaped valve member of the first, non-helical spring, directionally biased valve arrangement.
- 10
- 15

7. A liquid filter assembly according to claim 6 wherein:
  - (a) the first, non-helical spring, directionally biased valve arrangement is surrounded by the extension of suction filter media.

- 20 8. A liquid filter assembly according to claim 5 wherein:
  - (a) the flow/pressure regulation valve comprises:
    - (i) a valve frame piece having opposite ends and a central flow passageway extending therebetween;
    - (A) a first end of the frame piece having an end aperture and an outer seal surface for a serviceable filter cartridge; and,
    - (B) a second end of the frame piece, opposite the first end, having an aperture defining the valve seat of the flow/pressure regulation valve.
- 25
- 30

9. A liquid filter assembly according to claim 8 wherein:

- (a) the suction filter media is surrounded by the first, non-helical spring, directionally biased valve arrangement.

10. A liquid filter assembly according to claim 5 wherein:

- 5 (a) the suction filter media is cylindrical.

11. A liquid filter assembly according to claim 5 wherein:

- (a) the suction filter media is secured to a valve from piece and the valve frame piece is secured to the housing side wall.

10

12. A liquid filter assembly according to claim 1 wherein:

- (a) the housing comprises: a filter head; and, a housing side wall;
  - (i) the filter head including:
    - (A) a filter head body;
    - (B) a top cover removable from the filter head body to define a service opening in the filter head;
    - (C) a bottom aperture positioned opposite the openable top cover and service opening;
    - (D) the first circulation loop liquid flow outlet arrangement; and,
    - (E) the circulation loop liquid flow inlet arrangement; and,
  - (ii) the housing side wall being positioned to extend through the bottom aperture in a direction opposite the top cover;
  - (A) the suction filter assembly being positioned at an end of the housing sidewall opposite the filter head.

20

25

13. A liquid filter assembly according to claim 12 wherein:

- (a) the housing side wall is removeably secured to the filter head; and,
- (b) the housing side wall and suction filter assembly are sized to be installed by projection through the service opening and the bottom aperture in the filter head body, when the openable top cover is removed.

30

14. A liquid filter assembly according to claim 12 including:

(a) a serviceable filter cartridge positioned with at least a portion thereof projecting into the interior of the housing;

5 (i) the serviceable filter cartridge being sized to be inserted through, or removed from, the service opening when the top cover is removed from the filter head body;

(ii) the serviceable filter cartridge including: a primary filter media section defining a central axis and having opposite ends; and, a bypass filter media section secured to, and separated from, the primary filter media section by a first end cap.

10

15. A liquid filter assembly according to claim 14 wherein:

(a) the filter cartridge includes a second end cap secured to an end of the primary filter media section opposite an end to which the first filter end cap is secured;

15 (i) the second end cap having a seal projection thereon configured to define a seal plane extending at a non-orthogonal angle to the central axis of the primary filter media section.

20

16. A liquid filter assembly according to claim 15 including:

(a) a stand pipe secured within the housing side wall at a position with at least a portion of the stand pipe surrounded by at least a portion of the primary media section and a portion of the stand pipe surrounded by at least a portion of the bypass filter media section;

25 (i) the first end cap of the filter cartridge being sealed to the stand pipe to define:

(A) an upper stand pipe section surrounded by the primary filter media section; and

30 (B) a lower stand pipe section surrounded by the bypass filter media section and separated from the upper

stand pipe section by the seal between the filter cartridge first end cap and the stand pipe;

5 (ii) the stand pipe having a central flow interior in non-filtering liquid flow communication with both: the circulation loop liquid flow outlet; and, the reservoir liquid flow inlet/outlet; and,

10 (b) a bypass valve arrangement positioned within the lower stand pipe section to selectively permit liquid flow through the bypass media section and into the flow interior of the stand pipe, by passage through the lower stand pipe section, in response to a bypass valve opening liquid pressure caused by occlusion of the primary filter media section.

17. A liquid filter assembly according to claim 16 wherein:

15 (a) the bypass valve arrangement comprises:

(i) a tubular valve member slidably received within the lower stand pipe section and slideable between an open orientation and a closed orientation; and,

20 (ii) a biasing member position to bias the tubular valve member to a closed orientation until the bypass valve opening liquid pressure is reached.

18. A liquid filter assembly according to claim 14 including:

25 (a) a valve frame piece secured to an end of the housing sidewall;

(i) the valve frame piece comprising a tubular member having first and second ends;

(ii) the valve frame piece including a central mounting ring thereon;

30 (A) the valve frame piece being secured in place with the central mounting ring in engagement with the housing sidewall with: a first portion of the valve frame piece, on a first side of the central ring, projecting into an interior of the housing side wall; and a second portion

of the valve frame piece, on a second side of the central ring, projecting axially outwardly from the housing side wall;

5 (iii) the first portion of the valve frame piece having a bypass flow aperture arrangement therein; and

(b) the bypass valve arrangement includes a tubular valve member positioned within the first portion of the valve frame member and secured in covering relation to the bypass flow aperture arrangement by a bypass valve biasing member until the bypass valve opening pressure is reached; and

10 (c) a flow/pressure regulation valve arrangement including a flow/pressure regulation control valve member operably positioned over the second end of the valve frame piece.

15 19. A filter cartridge comprising:

(a) a primary filter cartridge section comprising media surrounding a central volume and defining a central axis;

(b) a bypass filter cartridge section;

20 (c) a first end cap positioned between the primary filter cartridge section and the bypass filter cartridge section;

(i) the primary filter cartridge section and the bypass filter cartridge section each being secured to the filter cartridge;

(ii) the first end cap being an open end cap including a seal member thereon, positioned to seal the first end cap against a tube projecting inside of the first end cap, in use;

25 (d) a second end cap positioned at an opposite end of the primary filter cartridge section from the first end cap;

(i) the second end cap being an open end cap and including an outer seal mount thereon defining a seal plane extending non-orthogonal to the central axis; and,

30 (ii) the second end cap including a central projection thereon extending in a direction opposite the primary filter cartridge;

the central projection including an aperture therein, for engagement with a housing top, in use.

20. A filter cartridge according to claim 19 wherein:

5 (a) the outer seal mount defines a seal plane extending at an acute angle within the range of 30° - 60° with the central axis.

21. A filter cartridge according to any one of claims 19 and 20 wherein:

(a) the primary filter cartridge section includes an inner support.

10

22. A filter cartridge comprising:

(a) a primary filter cartridge section comprising media surrounding a central volume and defining a central axis;

(b) a bypass filter cartridge section surrounding a central volume and defining a central axis;

15 (c) a first end cap positioned between the primary filter cartridge section and the bypass filter cartridge section;

(i) the primary filter cartridge section and the bypass filter cartridge section each being secured in the filter cartridge;

20

(ii) the first end cap being an open end cap and including a tubular axial projection having an outside surface and extending away from the primary filter cartridge section and to a location surrounded by the bypass filter cartridge section;

(iii) the first end cap including a seal member mounted on an outside surface of the tubular axial projection on the second end cap at a location spaced from, and surrounded by, the bypass filter cartridge to define a structural member receiving slot therebetween; and,

25

(d) a second end cap positioned at an opposite end of the primary filter cartridge section from the first end cap;

30

(i) the second end cap being an open end cap and including a tubular, axial, projection having an outside surface extending away from the primary filter cartridge section; and,

- (ii) a housing seal member mounted on the outside surface of the tubular axial extension of the second end cap.